LOK JAGRUTI UNIVERSITY (LJU)

INSTITUTE OF ENGINEERING AND TECHNOLOGY

Department of Chemical Engineering (708)

Bachelor of Engineering (B.E.) - Semester – V

Course Code:	**017083504**
Course Name:	**Instrumentation & Process Control**
Category of Course:	Professional Core Course (PCC)
Prerequisite Course:	Material and Energy Balance Calculations Basics of Differential Equations

Teaching Scheme				
Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Credit**	**Total Hours**
4	**0**	**2**	**5**	**40**

Syllabus

Unit No.	Topic	Prerequisite Topic	Successive Topic	Teaching Hours
01	**Introduction**			**4 (10%)**
	1.1 The concept of process dynamics and control .			
	1.2 Review of Laplace transform methods.			
	1.3 Laplace transform of disturbances and building functions, dynamic model building of simple systems.			
02	**Linear Open Loop System**			**6 (15%)**
	2.1 Physical examples of first order systems .	Mass balance and Energy balance Equations, Transform of Laplace		
	2.2 First order system response for step, impulse and sinusoidal inputs, linearization of non-linear models, response of first order system in series.			
	2.3 Second order systems and their response, estimation of system parameters.			
03	**Linear Closed Loop System**			**6 (15%)**
	3.1 Block diagram, Standard block diagram symbols.			
	3.2 Negative and positive feedback, Servo problem v/s regulator problems.			
	3.3 Development of block diagrams, Process measuring element, Controller, Final control element.			
	3.4 Closed Loop Transfer Functions: Block diagram reduction, Overall transfer function for single loop system, Overall transfer function for change in load.			
	3.5 Overall transfer function for multi loop control system, process and instrumentation diagrams, parts of control system.			
04	**Controllers**			**3 (7.5%)**
	4.1 Modes of control action,			
	4.2 Control system and its closed loop transfer function.			
05	**Stability**			**4 (10%)**
	5.1 Concept of stability, Definition of stability (linear system), Stability criterion .	Basics of Differentiation, Matrix Techniques		
	5.2 Characteristic equation, Routh test for stability, Routh array, Method of Root.			
	5.3 Locus for stability analysis, Nyquist stability criterion.			
06	**Process Application**			**5 (12.5%)**
	6.1 Controller tuning rules, control of complex chemical processes and equipment .			
	6.2 Control valve sizing .			
	6.3 Introduction to real time computer control of process equipment.			
07	**Introduction to Industrial Instrumentation**			**2 (5%)**
	7.1 Measurement and its classification by physical characteristics, direct and inferential measurement, on and off line measurement.			
	7.2 Static and Dynamic Characteristics of Instruments: Types of errors and uncertainties in instrumentations.			
	7.3 Static performance parameters– accuracy, repeatability, precision, threshold, sensitivity, resolution, linearity, range and span, hysteresis, dead band, drift, backlash, etc.			
	7.4 Dynamic characteristics of instruments– response to periodic, transient, and random signal inputs; Compensation.			
08	**Temperature Measurement**			**4 (10%)**
	8.1 Temperature scales.			
	8.2 Solid, liquid and gas expansion thermometers .			
	8.3 Filled system thermometers .			
	8.4 Electrical temperature sensors			
	8.5 Thermistor and thermocouples			
	8.6 Pyrometers			

09	**Measurement of Pressure**			**3 (7.5%)**
	9.1 Elastic pressure transducers, electrical transducers, inductance type pressure transducers			
	9.2 Forced balanced pressure gauge, measurement of differential pressure			
	9.3 Vacuum measurement			
	9.4 Techniques for protection of pressure gauges			
10	**Measurement of Level**			**3 (7.5%)**
	10.1 Direct level measurement			
	10.2 Indirect level measurement methods - hydrostatic, electrical capacitance, radiation, ultrasonic, solid level measurement			

Major Components/ Equipment	
Sr. No.	**Component/Equipment**
1	Thermometer
2	Tank System
3	Mixing system (provided with stirrer)
4	Temperature Control Trainer
5	Pressure Control Trainer
6	Flow Control trainer
7	Scada system

Sr No.	**Practical Title**	**Link to Theory Syllabus**
1	Response of first order system: thermometer.	Unit 2
2	Response of first order liquid level system	Unit 2
3	Response of mixing process	Unit 2
4	Response of Interacting tanks	Unit 2
5	Response of Non-Interacting tanks	Unit 2
6	To study real time computer control of process equipment	Unit 6
7	To study control of Temperature measuring devices (Temperature control trainer)	Unit 8
8	To study control of Pressure measuring devices (Pressure control trainer)	Unit 9
9	To study control of Level measuring devices (Level control trainer)	Unit 10

Proposed Theory + Practical Evaluation Scheme by Academicians
(% Weightage Category Wise and it's Marks Distribution)

L:	**4**	**T:**	**0**	**P:**	**1**

Note: In Theory Group, Total 4 Test (T1+T2+T3+T4) will be conducted for each subject.
Each Test will be of 25 Marks.
Each Test Syllabus Weightage: Range should be 20% - 30%

Group (Theory or Practical)	**Group (Theory or Practical) Credit**	**Total Subject Credit**	**Category**	**% Weightage**	**Marks Weightage**
Theory	**4**	**5**	MCQ	24%	30
Theory			Theory Descriptive	16%	20
Theory			Formulas and Derivation	16%	20
Theory			Numerical	24%	30
Expected Theory %	**80%**		**Calculated Theory %**	**80%**	**100**
Practical	**1**		Individual Project	0%	0
Practical			Group Project	20%	100
Practical			Internal Practical Evaluation (IPE)	0%	0
Practical			Viva	0%	0
Practical			Seminar	0%	0
Expected Practical %	**20%**		**Calculated Practical %**	**20%**	**100**
Overall %	**100%**			**100%**	**200**

Course Outcome	
	Upon completion of the course students will be able to
1	Able to comprehend process dynamics concepts, mathematical models, and constructing mathematical models for chemical and processes through unsteady-state mass and energy balances.
2	To learn and implement concepts of linear closed-loop systems, encompassing block diagrams, feedback types, controller development, and understanding their connection to closed-loop transfer functions and control action modes.
3	Able to learn stability concepts and their application to process control, alongside expertise in industrial instrumentation encompassing measurement classification, characteristics, errors, and compensation techniques.
4	To have proficiency in temperature, pressure, level, and vacuum measurements, employing various methods and sensors, and possessing expertise in safeguarding pressure gauges.
Suggested Reference Books	
1	Process Systems Analysis and Control, Coughanowr, D. R., LeBlanc, S, McGraw-Hill, 3rd edition (2008).
2	Chemical Process Control: An Introduction to Theory and Practice, Stephanopoulos, G, Pearson Education (1984).
3	Process Dynamics and Control, Seborg, D.E., Edgar, T.F., Mellichamp, D.A., John Wiley (2003),2nd edition.
4	Fundamentals of Industrial Instrumentation and Process Control, William C. Dunn, McGrawHill (2005).
5	Industrial Instrumentation and Control, S.K. Singh, McGraw-Hill, 3rd edition, (2008).
6	Process Control and Instrumentation, P. Vyas, Denett & Co.
7	Industrial Instrumentation, Donald .P. Eckman, John Wiley & Sons Inc, New York.

List of Open Source Software/Learning Website	
1	https://nptel.ac.in/courses/103/103/103103037/
2	https://www.coursera.org/learn/sensor-manufacturing-process-control#syllabus
3	https://nptel.ac.in/courses/103/105/103105064/
4	https://www.udemy.com/course/introduction-to-process-control-and-instrumentation/

Hands On Project

Sr. No.	Hands On Project	Linked with Unit
1	To obtain transfer function for boiler system	Unit-2
2	To obtain transfer function for a spring pulley connected from one end	Unit-2
3	To study working of Air Conditioner based on loop system	Unit-3
4	To study working of Hand Dryer based on loop system	Unit-4
5	To study working of Washing Machine based on loop system	Unit-4
6	To determine stability of the given system	Unit-5
7	To apply real time computer control to given process equipment	Unit-6
8	To study temperature sensing of hot moving object	Unit-8
9	To determine pressure at extreme conditions(High Temperate, Corrosion , etc)	Unit-9
10	To apply concept of level measurement in any daily use equipment/gadget	Unit-10